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FINANCING OF INDUSTRIAL INNOVATIONS IN INDIA HOW EFFECTIVE ARE TAX INCENTIVES FOR R&D?

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The initial discussions that I had with Pinaki Chakraborty were very useful. I received excellent help from M.Parameswaran for estimating the coefficients of elasticity of R&D expenditure wrt tax foregone. An initial version of the paper was presented as a lecture at the PGP-PMP course at the Indian Institute of Management- Ahmedabad and at the second conference of micro evidence on innovation in developing economies at the Renmin University of China, Beijing. The comments received from the participants and especially Pierre Mohnen is gratefully acknowledged. I also received valuable comments from Professor K. K. Subrahmanian. Research assistance was provided by Riju Prakash J.S. But none of them are to be implicated for any errors that may still remain.

ABSTRACT

The paper surveys the instruments that are available for innovation financing in India. It identifies three such instruments, namely research grants and loans, venture capital and tax incentives. The effectiveness of all these instruments are then examined in some general fashion, but one of the instruments, namely tax incentives are subject to a detailed empirical scrutiny in terms of its effectiveness. We have constructed a dataset containing firm belonging to four different industries which have claimed these tax incentives. For these firms we estimated the elasticity of R&D expenditure wrt tax foregone. The resulting analysis showed that while the instruments have been targeted well at the right sort of industries its effect in spurring additional investments in R&D is open to question.

Key words: Public R&D support; R&D investment; Evaluation, Tax foregone, Innovation policy, R&D policy, R&D investment, Innovation, India.

JEL Classification : H32; 031; O38

Introduction

The government in India is on a major innovation drive like the governments across the developing world and especially that of China. This drive could be found in several policy measures enunciated over the past ten years or so and especially in the Science and Technology Policy of 2003, where in it is stated that the government targets the expenditure on S&T to be about 2 per cent of GDP and this is to be largely contributed by the industry through significant increases in industrial R&D. Industrial R&D, therefore, may have to be incentivized through the provision of a variety of fiscal incentives such as tax incentives. This thinking again reflects the worldwide move toward using non-interventionist, but market-friendly forms of increasing investments in industrial R&D and within this scheme of things tax incentives form an important instrument. In India, even as early as 2001, the existing tax treatment of R&D had undergone some upward revisions, but targeted more specifically at around eight high and medium technology based industries. Although a few studies are available on the financing of industrial innovation, with rare exceptions, most of these have been descriptive, merely cataloguing the various schemes available for encouraging investments in industrial R&D. However no analytical studies on the effectiveness of these incentives in the specific Indian context are available. This is significant as recent estimates by the Ministry of Finance showed that the amount of corporate tax foregone consequent to the tax treatment of R&D has been increasing at a rate of 2.4 per cent per annum over the last four fiscal years until 2007-08: in 2004-5 about Rs 23180 million of corporate tax revenue had been foregone as a result of the operation of this scheme, but this is expected to be marginally down to about Rs 20240 million in 2007-08. It is seen that about 10 per cent of the corporate income tax is foregone as a result of various tax concessions of which R&D tax incentive is one such. In the context, the purpose of the present study is to analyse the effectiveness of a specific tax scheme that has been in operation since 2001. In very specific terms, this is accomplished by computing the elasticity of industrial R&D expenditure in India in response to a unit reduction in the cost of performing R&D. Such estimates of elasticity of R&D will be very helpful in judging whether the tax incentive for R&D is effective in stimulating proportionate investments in R&D.

The paper is structured into four sections. Section 1 analyses the innovative performance of India by employing a number of conventional and new indicators. The second section surveys the various financial instruments that are available for financing of innovation. The third section measures the effectiveness of tax incentives for financing R&D expenditures. The fourth and final section sums up the main findings of the study and identifies the policy conclusions that may emanate from this exercise.

I. India's innovative performance : India is generally referred to as an emerging knowledge superpower although her current record on this issue is rather mixed. We seek to analyse this record by employing a variety of conventional indicators as new indicators such as those emanating from innovation surveys are not available in the Indian context for the present.[1] I consider three conventional indicators:

i. Trends in R&D investment;
ii. Trends in patenting;
iii. Trends in technology trade balance

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1 The Department of Science and Technology (DST), Government of India is in the process of conducting a pilot innovation survey by employing a CIS compliant survey instrument. The results of this pilot survey may become available through June 2008 and this is to inform a larger nation wide innovation survey to be conducted during the latter half of 2008.

To the extent possible, the analysis is conducted in a comparative fashion by taking China as the comparator country.

Table 1: Trends in R&D Investment, 1980-81 through 2003-04 (Rs in Millions)

	Gross Expenditure on R & D (Rs. in Millions)				
	At Current Prices	At Constant Prices (Base year 1993:94)	Nominal growth rate (%)	Real Growth rate	GERD to GDP ratio
1980-81	7605.2	23421.6			
1981-82	9407.3	26297.1	23.70	12.28	0.58
1982-83	12060.3	31175.4	28.20	18.55	
1983-84	13811	32786.4	14.52	5.17	
1984-85	17815.5	39386.3	29.00	20.13	
1985-86	20687.8	42611.4	16.12	8.19	0.83
1986-87	24354	46868.1	17.72	9.99	0.88
1987-88	28530.7	50202.3	17.15	7.11	0.91
1988-89	33472.6	54345.1	17.32	8.25	0.9
1989-90	37257.4	55858	11.31	2.78	0.86
1990-91	39741.7	53972.4	6.67	-3.38	0.78
1991-92	45128.1	53867.9	13.55	-0.19	0.77
1992-93	50046	54947.8	10.90	2.00	0.79
1993-94	60730.2	60730.2	21.35	10.52	0.78
1994-95	66224.4	604253	9.05	-0.50	0.70
1995-96	74838.8	62634.4	13.01	3.66	0.70
1996-97	89136.1	69497	19.10	10.96	0.72
1997-98	106113.4	77507.6	19.05	11.53	0.76
1998-99	124731.7	84362.6	17.55	8.84	0.78
1999-00	143976	93751	15.43	11.13	0.82
2001-01	161988	101962.8	12.51	8.76	0.85
2001-02	170381.5	103720.9	5.18	1.72	0.82
2002-03	18000.6	105225.7	5.65	1.45	0.80
2003-04	197269.9	111989.3	9.59	6.43	0.78
Average rate of growth (pre reform)			18.17	8.91	0.81
Average rate of growth (post reform)			13.22	6.57	0.77

Source: Department of Science and Technology (2006)

Note: Pre reform refers to the period 1980-81 through 1990-91 and post reform refers to the period 1991-92 through 2003-04; For the pre reform period it is GERD to GNP ratio, but given the fact that in India the ratio of GDP to GNP works out to unity, it does not really matter whether one takes to ratio of GERD to GDP or GNP.

The following inferences can be drawn from the above Table: (a) Both in nominal and in real terms, there has been a decline in the overall GERD; and (b) Even the GERD to GDP ratio too have declined during the post reform period. From this, one has to be very cautious in drawing any strong inferences about the innovative potential of the country. This is because much of the overall R&D (GERD) of the country is performed in the public sector in defense, space, atomic energy, health and agriculture. Industrial R&D forms only about 20 per cent of the GERD. However the share of the industrial sector has shown much increase (Table 2) during the period.

Sector of Performance of R&D: See Table 2. In India much of the R&D is actually performed by the government or public sector. However the share of the business enterprises sector has shown some sharp increases. It now accounts for about 20 per cent of the R&D. The corresponding figure for China is as much as 69 per cent. The higher education sector represented by universities and research institutes

Table 2: Sector of performance of GERD in India, 1970-70 through 2004-05 (percentage shares)

	Government	Industry	Higher Education
1970-71	89.55	10.45	
1975-76	88.13	11.87	
1980-81	84.13	15.87	
1985-86	87.82	12.18	
1990-91	86.16	13.84	
1995-96	78.26	21.74	
1998-99	75.79	21.17	3.04
1999-00	77.21	18.46	4.33
2000-01	77.94	18.05	4.02
2001-02	76.48	19.33	4.20
2002-03	75.56	20.27	4.17
2003-04	75.44	20.05	4.51
2004-05	73.92	19.81	4.88

Source: Department of Science and Technology (2006) accounts for only 5 per cent of total R&D performed in the country. Notwithstanding the data problems, it is clear that the share of this sector has only shown some slight increases during this period.

Growing Privatization of Industrial R&D: Mani (2007) had shown that increasingly much of the industrial R&D is actually expended by private sector enterprises. I extend this analysis to the most recent period for which data are available (Table 3) and find that this is indeed the case. An important hypothesis that arises from these data (as contained in Table 1 through 3), is that one sees a decline in the growth rate of industrial R&D when increasingly that R&D is performed by private sector enterprises. Does this mean that the private sector is experiencing any Arrowian appropriability problems?. This hypothesis makes the study of external financing of industrial R&D in India a relevant one. During this phase when investments in R&D are declining one sees that the government is putting in place a number of financial support measures that seeks to reverse this declining trend. A study of the effectiveness of these financial measures thus assumes much significance.

Industry-wide Distribution of R&D: Within the industrial sector six industries (pharmaceutical, automotive, electrical and electronics, chemicals and defence) account for about two-thirds of the total industrial R&D (Table 4). Among these various industries one just stands out from the rest, namely the pharmaceutical industry as the industry alone accounts for about 20 per cent of the total R&D expenditures. In fact, later on I will show that even in the case of output indicators it is the pharmaceutical industry that is the best. In short, it may not be incorrect to say that India's national system of innovation is dominated by the sectoral system of innovation of the pharmaceutical industry. Another second in the line is the automotive industry. This industry is composed of both the vehicle manufacturers and the auto parts sub sectors. Both the industries are also characterised by competitive structures with a number of foreign and domestic manufacturers co-existing and

Table 3: Growing privatisation of industrial R&D in India, 1985-86 to 2002-03 (Rs in Millions at current prices)

	Public Sector Enterprises 1	Government Research Institutions 2	Total government 3	Private Sector enterprises 4	Industrial R & D 5 = (3 + 4)	Share of Private Sector in Total Industrial Development
1985-86	1986.18	1622.7	3608.88	2519.44	6128.32	41.11
1986-87	2356.99	1723.36	4080.35	2916.33	6996.68	41.68
1987-88	2884.66	1851.29	4735.95	3102.67	7838.62	39.58
1988.89	3421.24	2093.28	5514.52	4176.25	9690.77	43.10
1989-90	4129.01	2395.21	6524.22	4905.94	11430.16	42.92
1990-91	4145.33	2491.88	6637.21	5499.81	12137.02	45.31
1991-92	4843.88	2745.50	7589.38	6369.44	13958.82	45.63
1992-93	5139.50	2993.65	8133.15	8362.47	16495.62	50.70
1993-94	5428.11	N.A.	N.A.	9825.37		
1994-95	4146.09	3564.00	7710.09	13188.70	20898.79	63.11
1995-96	4275.76	4116.99	8392.75	16270.69	24663.44	65.97
1996-97	5360.52	4440.00	9800.52	23307.50	33108.02	70.40
1997-98	5392.40	5641.30	11033.70	24382.50	35416.20	68.85
1998-99	6738.70	7133.20	13871.90	21781.10	35638.00	61.08
1999-00	7576.30	7808.82	15385.12	21781.10	37166.22	58.60
2000-01	8428.80	8641.20	17070.00	24114.00	41184.00	58.55
2001-02	7673.70	8922.60	16596.30	27874.80	44471.10	62.68
2002-03	8089.50	9512.50	17602.00	30649.30	48251.30	63.52

Source: Department of Science and Technology (2006) competing with each other. The auto parts subsector of the industry has a rather high export intensity of nearly 20 per cent and this meant that the subsector has been continuously investing in technology to upgrade itself and meeting the technological challenges posed by its foreign buyers.

Trends in Patenting

I consider both US and triadic patents secured by Indian inventors. I start with the US patents. Among the BRICS (Brazil, Russia, India, China and South Africa) countries, India has registered the highest growth rate in patenting (Table 5). From an earlier analysis (Mani, 2007), it is seen most of the Indian patents are by domestic companies and that too in the pharmaceutical area[2]. However in the more recent period, the share of patents secured by affiliates of MNCs based in India is on the increase.

Triadic patent data (patents secured by an inventor from three different patent offices (namely the USPTO, European Patent Office and Japanese Patent Office) also shows that India has registered one of the highest growth rates in Triadic patent grants during the period 1975 through 1995.

The performance of the country in patenting thus confirms the results obtained in R&D investments, namely that most of the patents are secured by domestic private sector companies that too in the area of pharmaceutical technologies. In other words the patenting data further supports the evidence that I found earlier in terms of India's innovation system being dominated by the sectoral system of innovation of her pharmaceutical industry.

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2 Bulk of the US patents granted to Indian inventors are in two US patent classes namely, in 532 Organic Compounds (includes Classes 532-570), and in 424 Drug, Bio-Affecting and Body Treating Compositions (includes Class 514).

Table 4: Industry-wide distribution R&D (cumulative share in per cent 1998-99 through 2002-03)

Industry	Share
Drugs & Pharmaceuticals	19.30
Transportation	15.16
Electricals & Electronic Equipment	8.94
Chemicals (other than Fertilisers)	8.35
Defence Industries	8.32
Fuels	6.12
Information Technology	4.69
Metallurgical Industries	4.21
Telecommunications	3.75
Miscellaneous Industries	2.38
Soaps, Cosmetics & Toilet Preparations	2.37
Industrial Machinery	1.84
Biotechnology	1.59
Food Processing Industries	1.39
Agricultural Machinery	1.33
Misc. Mechanical Engineering Industries	1.22
Textiles (Dyed, Printed, Processed)	1.21
Consultancy Services	1.05
Other industries	6.77
Total	100.00

Source: Department of Science and Technology (2006)

Trends in Technology Trade Balance: India's technology trade balance has been has been negative and rising all through the more recent years (Table 5). However during the period since 2005, it has turned positive essentially due to the receipts under R&D outsourcing. India, along with China has now become a major recipient of R&D outsourcing deals. Most of India's R&D outsourcing deals is in the areas of pharmaceutical and telecommunications industries.

Table 5: Trends in US Patenting of Indian Inventors, 1994-2007 (number of utility patents)

	Pre 1994	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Compound rate of growth
China, P. Rep	431	48	62	46	62	72	90	119	195	289	297	404	402	661	772	23.82
South Africa	2390	101	123	111	101	115	110	111	120	113	112	100	87	109	82	-1.59
China, Hong Kong	701	57	86	88	81	160	155	179	237	233	276	311	283	308	338	14.67
India	428	27	37	35	47	85	112	131	178	249	342	363	384	481	546	26.02
Russian Federation	3	38	98	116	111	189	181	183	234	200	203	169	148	172	188	13.09
Brazil	752	60	63	63	62	74	91	98	110	96	130	106	77	121	90	3.17

Source: USPTO (accessed on April 11, 2008)

Table 6: Trends in technology trade balance, 2000-2006 (in millions of US $)

	Payments	Adjusted Payments	Receipts	Adjusted Receipts	TBoP	Adjusted TBoP
2000	311		54		-257	
2001	236		60		-176	
2002	361		22		-339	
2003	352		23		-329	
2004	444		32		-412	
2005	712	1890	71	1709	-641	-181
2006	729	2514	729	5288	-600	2774

Thus, based on the evidence presented it can safely be concluded that India's innovation performance has actually improved if one takes the output measure of R&D. But the investments in R&D, both in the country as a whole and in the industrial sector have actually declined. Another point that came out of the analysis was that the country's innovative performance is concentrated in certain specific industries such as the pharmaceutical one and as such is not widespread. In fact we tend to demonstrate that the government too has targeted this industry for enhancing its innovative output by offering a variety of financial incentives. In the following, we survey these various instruments for financing innovation.

II. Survey of Instruments for Financing Innovations: The country has three different types of financial arrangements for financing innovations. They are: (i) Research grants; (i) Tax incentives; and (iii) Venture capital. The former two are almost entirely provided by various governmental agencies while the latter is now very much in the private sector. Implicitly the innovation policy makers in the country has adopted a linear view of innovation with three distinct phases: birth, survival and growth phases. All the research grants and venture capital are in the birth phase of the innovation chain while the tax incentives are almost entirely in the growth phase. See Figure 1. Although this might appear to be a very idealistic picture from the financing of innovation point of view with research grants and venture capital at the birth stage where the market failures are great and tax incentives at the growth phase when firms have established themselves and are in a position to engage in formal intramural R&D activities, in actual operation the research grants and venture capital financing does address only a small segment. Most of the research grants are either addressed to public sector enterprises or individual researchers. There are of course notable exceptions to this. The venture capital in the industry although growing by leaps and bounds is increasingly intertwined with the private equity industry and therefore cannot be taken in its entirety as equivalent to technology financing. With these caveats we attempt at a survey of the various instruments that

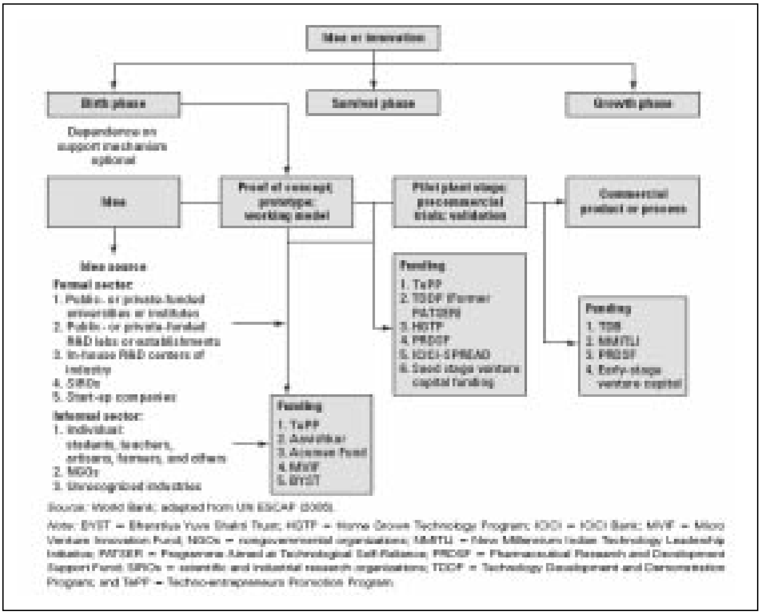

Figure 1: Financing of innovation in India (c2007)
Source: Dutz (2007)

are available. The purpose here is to just map out the plethora of instruments that are available for technology financing, actually available in the country at present. In the next section, we take one of these namely the tax instruments for some in depth examination in terms of its effectiveness in driving up R&D investments.

We organise our discussion of these schemes into three broad areas by type of instruments, namely (a) research grants; (b) venture capital; and (c) tax incentives.

(a) Research Grants: Under this we consider three grant or loan schemes. They are: (i) Finances from the Technology Development Board (TDB); (ii) Techno-entrepreneurs Promotion Programme (TePP); and (iii) the New Millennium India Technology Leadership Initiative (NMTLI).

(i) TDB: The TDB was created by an Act of the Parliament in 1995 and commenced operation from 1996. TDB basically seeks to support financially the commercialisation of indigenous technology (whether obtained or developed from a publicly funded R&D or not, including aspects such as improvements, modifications replacement of imported inputs, conformance to domestic and global regulatory standards, etc. and even for adapting and commercializing imported technology that entail crucial modifications to suit domestic markets and or further development of a ‘proof of concept or design’. The TDB provides financial support through: a) a loan of up to 50 per cent of the project costs at simple interest (of 6% earlier and now lowered to 5%) with repayment in five years after project completion (and a royalty payment during the period of loan, which has now been dropped); b) participation in equity of companies up to 25 per cent of paid up capital; and c) Grants-in-aid. As of March 2005, TDB had supported around 141 projects with an estimated project cost of Rs.20450 million (of which TDB sanctioned assistance is of around only Rs.6650 million). This means that the TDB assistance works out to only a third of the total project costs. TDB has predominantly used the loan instrument for support; it has participated in equity of only one company and given just three grants-in-aid;. The grant of Rs 540 million by TDB to National Aerospace Laboratories (NAL) for development and type certification of a 14 seater aircraft is the largest project support ever made by TDB - normally no private sector venture capital fund would have financed the NAL development. TDB's reluctant use of equity as a mechanism for support is a clear indication that it has been risk averse in funding start-ups and new ventures.

The Health and Medical sector accounts for 25 per cent of TDB funding followed by Engineering (15 per cent) and Road Transport (14 per cent). Some successful projects supported by TDB are: development and production of Hepatitis B vaccine (as a result of which the domestic price has dropped to one tenth), Recombinant Streptokinase (second in the world), corDECT, the Wireless in Local Loop access technology, Bharat II variant of Indian car Indica, the first Indian electric vehicle REVA and so on.

Hitherto there has been only one review of it in the first five years of its operation- by the Administrative Staff College of India, Hyderabad (ASC). The ASCI survey showed that around 50 per cent of the agreements were successful i.e., products released in the markets and repayments to TDB commenced, another about 12 per cent were foreclosed but payments were committed/received, 8 per cent were failures and the rest about 20 per cent were those where success was doubtful. Of the successful projects, in over 70 per cent of the cases, the technology originated outside of publicly funded R&D system.

(ii) TePP: The programme was launched in 1998 to help realize the vast latent innovative potential of individual innovators in the country. The basic objective of TePP is for individual innovators to emerge as technopreneurs - technology oriented entrepreneurs. TePP support is provided for in all areas except software development for which there are other avenues of support. It helps the inventor to identify and network with an appropriate R&D/academic institution for guidance, technical consultancy, development of models/prototypes, etc., assists in for filing and securing of intellectual property rights and finally linking up with appropriate source of finances for commercialisation of the product. TePP by itself provides financial support of up to Rs.1 million as a grant-in-aid to prove the idea and a similar amount for the second phase for commercialisation. Since its inception seven years ago, the programme has received over 5500 applications of which around 1200 have been assessed and of these, 207 projects supported.

(iii) NMTILI: The scheme was announced at the dawn of the Millennium in February 2000 by the then Finance Minister in his budget speech of 2000. The objective was to catalyse innovation-centered scientific and technological developments as a vehicle for select Indian industry to attain a global leadership position. The state run Council of Scientific and Industrial Research (CSIR) was assigned to manage the scheme. The Scheme departed from the past practice and policy and adopted a strategy of identifying, selecting and supporting technological and industry winners. The Government funds the entire project (in most cases) as a grant-in-aid for publicly funded R&D/academic partners and as a soft loan (3 per cent simple interest payable in 10 installments) to the industry partner and also underwrites the risk of failure. Intellectual property rights aspects are equitably managed - generally IPRs belong to the group (s) developing it, which are licensed on a first right of refusal basis to the industrial partner on mutually agreed terms with NMITLI managers as the umpire.

During 2000-2006 period, it has funded 42 projects with an outlay of about Rs.3000 million, involving 222 publicly funded R&D/academia groups and 65 industrial firms as partners. Predominantly the projects have been in the broad area of biotechnology (40 per cent) and in drugs and pharmaceuticals and chemicals (15 percent each) - areas in which CSIR has recognized core competencies. NMITLI projects, which are wholly funded by the government, enjoy an average of about Rs.70 million project funding - highest of all government technology development programmes. From the projects funded four products have been developed, viz.,

- Biosuite,
- a versatile portable software for bioinformatics,
- a PC based high end 3D visualization platform for computational biology; and
- Sofcomp, a simple and cost effective office-computing platform under Rs.10000 ($ 220 or so)

(b) Venture capital: The history of the venture capital industry in India may be traced to 1988 when a few (mostly state owned) venture capital funds were established on a loan from the World Bank. The industry is now one of the fastest growing in the world and according to some estimates the VC industry in India will overtake the UK one by 2009 or so. However increasingly the VC industry in India is only a small portion of the total private equity industry: in fact its relative share has gone down from 7 per cent in 2006 to about 4 per cent in 2007 although in number terms it works out to about a quarter of all such deals.

Table 7: Share of Venture Capital in Total Private Equity Industry in India, 2006 and 2007 (Value is in Rs Millions)

	Number of deals 2006	Number of deals 2007	Value of deals 2006	Percent share 2007	Value of deals 2007	Percent Share 2007
Venture Capital	94	98	505	7.06	542	3.81
Growth PE	14	32	364	5.09	1321	9.28
Late	104	136	3396	47.46	5070	35.62
Pre IPO	4	14	43	0.60	434	3.05
PIPE	60	80	1401	19.58	4210	25.58
Buyout	13	7	370	5.17	173	1.22
Buyout-Large	1	3	765	10.69	474	3.33
Other	8	17	312	4.36	2010	14.12

Much of the VC investments are in the Banking, Financial Services and Insurance industries followed by telecom, IT and ITES sectors.

(c) Tax incentives : India offers a variety of tax incentives to enterprises for committing resources to domestic R&D, both intramural and extramural. They can broadly be classified into those which are input based and those which are output based (Table 8). Of these two broad categories, the input based ones are more popular. Within the input based category although there are eight different types of tax incentives, the one which has a long history and which enjoyed by maximum number of companies is the one that provides a weighted deduction of 150 per cent on any expenditure on intramural R&D (See A (a) in Table 8). This has been in operation in its present form since 1998 and it applies to about 10 different types of industries[3] although the 9th and the 10th industries (namely seeds and agricultural implements) were added only in the latest budget for the fiscal year 2008-09.

This is not a permanent scheme and the incentives under this head are available according to the term stipulated in the successive union budgets. Given the fact that this is the most comprehensive tax scheme for R&D, we undertake an analysis of its effectiveness.

Table 8: Input and output based tax incentives for R&D in India (c2008)

A.	**Input based tax incentives**
	a weighted deduction of 150 per cent on any expenditure on in-house scientific research
(a)	weighted tax deduction for sponsored research in publicly funded R&D and on approved in-house R & D projects;

3 The ten industries are pharmaceuticals, biotechnology, chemicals other than pharmaceuticals, electronic equipment, computers, telecommunications equipments, automobiles , auto parts, seeds and agricultural implements.

(b)	customs duty exemption on capital equipment, spares, accessories and consumables imported for R & D by approved R&D units, institutions and SIROs;
(c)	excise duty waiver on indigenous items purchased by approved institutions/ SIROs for R & D;
(d)	accelerated depreciation allowance on plant and machinery setup based on indigenous technology;
(e)	customs duty exemption on imports for R & D projects supported by the Government;
(f)	ten year tax holiday for commercial R & D companies; and
(g)	a weighted deduction of 125 per cent on any payment made to companies engaged in research and development
B.	**Outcome based tax incentive**
(h)	excise duty waiver for 3 years on goods produced based on indigenously developed technologies and duly patented in any two of the following countries: India, European Union (one country), USA and Japan.

Source: Department of Scientific and Industrial Research (2007); and Ministry of Finance (2008)

III. Effectiveness of R&D Tax Incentives in India: An excellent review of the evidence on effectiveness of tax incentives for R&D and the methodologies used is found in Hall and Van Reenen (2000) and Mohnen (2007). However much of this evidence is based on the experience of OECD countries and notably that of the United States. The authors both describe and criticize the methodologies used to evaluate the effect of the tax system on R&D behaviour and the results from different studies. In the current (imperfect) state of knowledge Hall and van Reenen conclude that a dollar in tax credit for R&D stimulates a dollar of additional R&D. Studies on the effectiveness of tax incentives in the context of developing countries are rare[4].

The specific type of R&D tax incentive followed in India conforms to those that are in proportion to the level of the expenses on R&D. Further it manifests itself as an immediate write-off or expensing.

Within the specific context of India no such studies are available. The government itself has been rather concerned with the revenue foregone as a result of various tax concessions given to the corporate sector. Consequently beginning with the Union Budget for 2004-05, the government has been publishing data on the amount of tax revenue foregone as a result of various tax incentives or concessions given to the corporate sector. The revenue foregone as a result of R&D tax incentives has been computed (by the Ministry of Finance) and this is presented in Table 9.

Table 9: Tax foregone due to R & D tax incentives in India (Rs in Millions)

Column	Revenue foregone due to R & D incentives	Growth rate	Revenue forgone due to all tax incentives	Share (%)
2004-05	2318		82680	2.80
2005-06	2839	22.48	101277	2.80
2006-07	1554	-45.26	144318	1.08
2007-08	2024	30.24	186125	1.09

Source: Government of India, Ministry of Finance (various issues)

4 There is a recent study evaluating the performance of R&D support programmes in the context of Turkey. See Özçelika and Taymaz (2008)

With the exception of 2005-06, it has averaged around Rs 2 billion per year and works out to about 1.08 to 2.80 per cent of the total revenue foregone. As result of the operation of these tax incentives the effective corporate tax rate for some of the industries covered under the scheme is significantly lower with the pharmaceutical industry garnering much of the incentives (Table 10).

Table 10: Effective corporate income tax rate for those industries covered under the R&D tax incentive scheme, 2006-07

Sl No	Industry	Statutory Corporate Income Tax Rate (in per cent)	Effective Tax Rate (in per cent)
1	Drugs and pharmaceuticals	33.66	13.91
2	Electronics, including computer hardware	33.66	17.04
3	Fertilizer, chemicals and Paints	33.66	22.17
4	Automobile and Auto parts	33.66	26.03

Source: Government of India, Ministry of Finance (2008), p. 59

Based on these, our hypothesis is that the effect of this tax incentive will vary across industries according to the effective tax rate. Although the incentive is same across the targeted 10 industries the effective rate can vary according to whether the firms in the industry has actually taken advantage of this scheme or not. Further it must also be borne in mind that the effective rate is a function of the sum of tax incentives enjoyed by a particular industry. It may be the fact that the pharmaceutical industry also enjoys a number of other tax concessions that their overall tax commitment is much lower than other industries in our sample.

In order to see whether the tax incentives have really lead to increased investments in R&D, we do two exercises. Firstly, we compile data[5] on R&D expenditures of seven of the eight original industries (Table 11). The only industry that is left out is the biotechnology industry as the data on this industry are not available[6]. The growth rate of the R&D expenditure of this sample is then compared with the growth rate of the R&D investments of the entire private corporate business enterprise sector (as contained in Table 3 above). The resulting analysis shows that the average growth rate of the industries receiving tax incentives is much higher than all the industries[7] (with the sole exception of 2000- the decline in R&D expenditure of all the firms enjoying R&D tax incentives in that year may purely be a statistical artifact).

This of course does not mean that the incentive is effective. All that it implies is that the government appears to have targeted the right sort of industries for granting this concession. Secondly, we compute the elasticity of R&D expenditure with respect to the tax foregone. Although in its actual operation, the tax incentive does not lead to any flow of resources from the government to the enterprise receiving the incentive; it leads to tax foregone by the exchequer. If the percentage change in the R&D is greater than the change in the tax foregone, the tax incentive is deemed to have been successful provided that the tax incentive accounts for a significant share of the R&D done by the enterprise. In the following we do this sort of an exercise.

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5 The data on R&D expenditures are compiled from the Prowess database of the Centre for Monitoring Indian Economy (CMIE), Mumbai.

6 We do not consider this as a major problem as much of the Indian biotechnology industry is made up of the Biopharmaceutical industry and since we have the data on R&D expenditures of the Pharmaceutical industry, the data on R&D expenditures of the Biotechnology industry is included as well.

7 Even according to Table 4, the industries such as pharmaceuticals, automotive and auto parts, chemicals other than pharmaceuticals, electronics and information technology account for over 50 per cent of the total R&D expenditure of the industrial sector as a whole.

Table 11: R&D expenditure of firms receiving R&D tax incentives, 1996-2006 (Rs in Millions)

Industry	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Pharmaceutical	3954.1	7110.1	4627.3	6075	5674.7	7610.8	8937	11218.4	16609.5	22928.1	29595
Chemical Industry other than pharmaceutical	1997.8	4842.9	2377.2	3178.3	2275	2368.2	2094.9	2407.6	2697.1	3303	4791
Electronics including Computer	88.4	132.7	41.4	39.2	87.3	108	57.3	12.6	349.6	71.5	417.9
Communication Equipments	112.9	499.9	395.5	383.1	429	641.1	750.4	603.7	1025.1	896.3	727.4
Automobiles	1552.2	2459.6	2856	2143.8	1453.1	1742.9	2878.2	3357.9	4183	7506.9	8848.1
Auto parts	407.2	516	682.9	757.7	947.2	1081.7	1121.1	1485.7	1691.3	2194.6	2505.9
Aircrafts	NA	NA	NA	NA	NA	NA	NA	2650.6	3091.4	3066.4	4336.2
Total	8112.6	15561.2	10980.3	12577.1	10866.3	13552.7	15838.9	21736.5	29647	39966.7	512215
Growth Rate (%)		91.82	-29.44	145.1	-13.6	24.72	16.87	37.23	36.39	34.81	28.16
Growth Rate of all Industries (%)		18.01	34.24	6.97	0.63	4.29	10.81	7.98	8.5		
Ratio		5.1	-0.086	22.09	-21.72	5.77	1.56	4.67	4.28		

Source: Own compilation based on the Prowess database of Centre for Monitoring Indian Economy (CMIE).

Elasticity of R&D Expenditure to Tax Foregone

The first step involved in this exercise is to estimate the tax foregone due to the operation of this specific R&D tax incentive scheme. This is done in two stages. In the first stage or instance, we estimate the total tax foregone (denoted as tf1) due to the operation of all tax incentives. This is based on the difference between the statutory corporate income tax rate and its effective rate (See the estimates of it in Table 10 above). Two caveats have to be borne in mind. First, the estimates are available only for four broad industry groups although it can be seen that it covers almost 7 of the 8 industries receiving tax incentives.[8] In the second stage we estimate the tax foregone (denoted as tf2) due to just R&D tax incentives alone. This estimation was done under an assumption. It was found that the revenue foregone due to R&D tax incentives worked out, on an average, 1.94 per cent of revenue foregone due to all kinds of tax incentives (basing oneself on data contained in Table 9 above). We, therefore took 1.94 per cent of total tax foregone (tf1) to arrive at tax foregone due to R&D tax incentives (tf2). In other words:

$$tf2 = tf1*0.0194 \text{---} (1)$$

For estimating the elasticity, we fitted the following functional form:

$$\ln R \,\&\, D_{it} = a+b_1\ln Sales_{it} + b_2 tf2_{it} + b_3 \ln Export + u_{it} \text{ ----------}(2)$$

For the estimation of elasticity, we create a panel data of firms reporting R&D expenditures in four of the broad industry groups for the years 2002 through 2006. The data are taken from the Prowess database published by the Centre for Monitoring Indian Economy. The unit of reference is therefore the firms and the firms are arranged by any of the four industries to which they belong. For each of the firms we have the data on R&D investments, tf1, tf2, Profit before Tax, Sales and Exports.

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8 The only industry that is left out is the aircraft industry. The Prowess database itself has started picking up data on R&D expenditure of this industry only since 2003. See Table 11.

Given the industry specificities we estimate (2) for each of the four industries under consideration. Before going into the estimation procedure for (2), we report the summary descriptive statistics of the important variables. See Table 12.

Table 12: Mean values of important variables

(Values are in Rs Crores, Intensities are in percentages)

	R & D Expen-diture	Research Intensity	Sales	Tax foregone	Exports	Subsidy intensity
Automotive	12.35 (39.50)	1.13	1088.42 (2668.18)	1.653 (4.299)	87.95 (265.01)	13.50
Chemicals	2.07 (4.17)	0.46	449.24 (151.04)	0.133 (0.431)	55.61 (137.43)	6.43
Electronics	7.4 (21.52)	2.41	306.58 (289.69)	0.218 (0.898)	40.71 (151.04)	2.95
Pharmaceuticals	19.05 (52.91)	5.99	318.09 (289.69)	0.23 (0.43)	122.05 (289.69)	1.21

Note: (i) R&D intensity is R&D as a per cent of Sales; and (ii) Subsidy intensity is Tax foregone 2 as a per cent of R&D; (iii) Figures in parentheses indicate standard deviation.

Sales and exports are taken as additional determinants of R&D. Sales is a proxy for the size of the firm and the assumption is that firms with larger sales devote large amounts to R&D. Exports on the contrary also encourages firms to commit more resources to R&D as sales in an international market requires that your product matches with the best in the world for that specific product. Further in the regression equation (2) , the explanatory variable tf2 depends on the amount of R&D spending. This implies that this explanatory variable is endogenous and OLS estimates are not consistent. Therefore, we estimate the model using Generalised Method of Moments (GMM) as suggested by Blundel and Bond (1998). In this method, the equation is first differenced to eliminate the firm specific fixed effect and endogenous variables are then instrumented. The estimation uses two types of instruments; for equation in differences lagged level variables from second lag onwards are valid instruments and for equation in level first lag of the endogenous variable in difference is valid instrument. In our estimation, we consider all explanatory variables as endogenous and therefore instrument them. The results are reported in Table 13. The table shows that Sargan statistics validates the over-identifying restrictions. The results on AR (2) suggests the absence of second order correlation. and thereby implies the validity of instruments used.

Table 13: Regression results

	Automotive	Chemicals (other than pharmaceuticals)	Electronics	Pharmaceuticals
ln tf2	-0.0045(-0.017)	0.429(3.08)**	-0.138(-0.59)	0.261(1.37)
ln sales	1.244 (2.93)**	0.470(1.78)*	0.816(1.93)**	0.394(1.10)
ln exports	-0.0734(-2.92)	-0.028(0.246)	0.091(0.624)	0.553(1.89)*
Constant	-6.262 (-2.48)**	-1.126(-0.703)	-4.26(-1.55)	-2.01(-1.08)
Sargan	30.12(0.181)	26.03(0.352)	23.34(0.50)	27.67(0.274)
AR (1)	-1.362(0.173)	-2.516(0.012)	-1.678(0.093)	-1.944(0.52)
AR (2)	-1.699(0.089)	-0.326(0.74)	-0.01(0.992)	-0.266(0.79)

Notes: ** Significant at 10 per cent level; * Significant at 5 per cent level

The following inferences can be drawn from the above exercise:

(i) The elasticity of R&D expenditure with respect to tax foregone as a result of the operation of the R&D tax incentive is less than unity for all the four industries, although it is significant only in the case of the chemicals industry. In two of the industries, namely in automotive and electronic industries the elasticity is even negative, although not significant. From this the reasonable interpretation that is possible is that tax incentive does not have any influence on R&D, excepting possibly in the chemicals industry where it has some influence although even in this case the change in R&D as a result of tax incentive is less than the amount of tax foregone. This lack of significant relationship between R&D and tax foregone can be rationalized by the fact that the tax subsidy covers only a very small percentage share (on an average 6 per cent) of R&D undertaken by the enterprises in the four broad industry groups. This is indicated by the column on subsidy intensity in Table 12. So our conclusion is that for tax incentive to be effective in raising R&D expenditures it must form a significant portion of R&D investments by an enterprise. It is not thus a determinant of R&D investments by enterprises. In fact this result corroborates the results of innovation surveys done in the context of such diverse countries such as Brazil and South Africa where innovating firm did not find government funds for innovation as an important instrument for financing their respective innovation efforts. In the Indian case even though 150 per cent of weighted deduction of R&D expenditure is allowed, the taxable income the firm has is not much. For firms to benefit from this specific incentive, their profit before tax has to be large. May be an incremental tax incentive of the type followed in the US and other western countries is likely to be more beneficial;

(ii) Sales (a proxy for size) is found to be a more important determinant. This is in line with the Schumpeterian hypothesis that large sized firms are able to devote more investments on R&D. Surprisingly exports turned out to have positive and significant influence on R&D only in the case of the pharmaceutical industry. The other two industries are much more inward looking where the domestic market is more important than the export one. In the case of the pharmaceutical industry much of the R&D is in the development of generic versions of known drugs which are then exported. So exports act as an important fillip.

One of the most important conclusions that emanate from our study is that tax incentives are not that effective in raising R&D expenditures because the amount of subsidy that the firm receives is not much. The market itself, domestic sales and some cases exports are important determinants for the enterprises to commit more resources to R&D. But despite this the Union Budget for 2008-09[10] has extended this tax treatment of R&D to two more industries, namely the production of seeds and the manufacture of agricultural implements. It may be that public policy making in this area is not informed by sufficient empirical exercises of this sort.

IV. Conclusions: Our study has shown that there have been improvements in the innovative output of Indian industry during the recent period since economic liberalisation. However this has been restricted to a few industries such as the pharmaceutical industry. India has three different types of financial incentives for R&D: research grants and loans, venture capital and tax incentives. Our analysis showed that the pharmaceutical industry has been a target of most of these financial incentives. There is thus a fine targeting of innovation financing in India. We endeavoured to estimate the coefficient of elasticity of R&D with respect to tax foregone as result of this incentive scheme. The resulting exercise showed that R&D expenditure of the concerned industries was inelastic. We also found that the incentives did not form a significant portion of R&D. It is therefore not prudent to make any comments on the effectiveness of R&D tax incentives. But we see that the size of the firm does appear to be an important determinant of R&D, at least, in the case of some of the industries. Allowing firms to become larger and

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10 See the Budget Speech of Mr P.Chidambaram for 2008-9, http://indiabudget.nic.in/ub2008-09/bs/speecha.htm, paragraph 168 (accessed on May 22, 2008).

through that process of growth enabling them to become larger investors in R&D may be a better policy than providing them directly with subsidies. It is also that the total number of firms enjoying these incentives is not too many. It remains to be seen whether this is due to any bureaucratic delays or difficulties in the actual administration of this incentive.

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